LINAC UPGRADE RF SYSTEM COMMISSIONING PROCEDURE SUMMARY

H.Pfeffer
5/4//92

We have several procedure sheets that will be followed in commissioning the LINAC RF systems. This summary is written to explain the relationships between the various procedures.

The sequence and content of the procedures is as follows:

1. MODULATOR INITIAL COMMISSIONING PROCEDURE
   This is the procedure by which we have already commissioned the modulator on a dummy load. It has the following elements.

   a. General system checks.-- Check out as many individual systems and components as we can.

   b. Non-power tests.--- Check all interlocks such as Safety System, water flow switches, etc.

   c. Power-on tests.--- Check components of system under 480 VAC power before turning the whole system on.

   d. Turn-on sequence indicating which operational trip circuits to test, and how to coordinate with radiation safety during turn-on.

2. PULSE TRANSFORMER ELECTRICAL SAFEGUARDING PROCEDURE

   This is a procedure for safe removal, installation, or maintenance of the Klystron/Pulse Transformer unit.

3. LINAC UPGRADE CHECK OUT LIST

   This is a checklist for the Klystron Interlock Chassis. The procedure establishes that all interlocks function and that all status readbacks are correct at the station monitor.

   This is accomplished by generating faults and checking for correct responses from the Klystron Interlock Chassis.

4. HARDWARE PROTECTION INTERLOCKS FOR KLYSTRON AND RF

   This procedure checks that all RF system hardware is properly installed and functioning properly.

5. MODULATOR ACCESS PROCEDURE SHEET/ NON-ACCESS PROCEDURE SHEET
   These sheets step through procedures for turning on the modulator from either the manually grounded and door-open state or the OFF state, in which the system has not been manually grounded.

6. RF STATION COMMISSIONING PROCEDURE
   This procedure goes through several stages:

   a. Turn on modulator to low level with no RF.

b. Step up modulator to full voltage level with no RF.

c. Turn on Klystron RF to minimally detectable level.

7. RF INCREMENT COMMISSIONING PROCEDURE

This procedure is followed every time the RF amplitude is increased to a level that has not been achieved and checked previously.

LINAC MODULATOR INITIAL COMMISSIONING PROCEDURE

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1/3/92

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I GENERAL SYSTEM CHECKS

A. ANALOG SIGNALS.

Put 10 V test voltage into each Current Driver input. Insert signal at the coax cable that has been disconnected from the relevant transducer. Measure signal at the front panel monitor of the Buffer Receiver module.

B. CONTROLLER

Check that Charging Supply Controller and PFN Controller take the right action for all relevant trips. Before starting, enable the charge pulse and verify you can hear the SCR switch being fired in the charging supply. To do this you have to connect a DC source to the input of V_CAP in the charging supply current driver and raise the voltage to 3 VDC or else the charge pulse originating in the controller will be inhibited.

	Charge Inh.	Bypass	Crowbar
1. PFN CONTROLLER			
a. Switch imbalance	X	X	X
b. Current driver	X	X	X
b. SCR trig OK	X	X	X
b. EOL Trip	X	X	-
b. Excess I	X	X	-
b. Excess V	X	X	-
c. Water Flow	X	X	-
c. Bias supply	X	X	-
c. X Ray trip	X	X	-
d. Temp trips			
EOL R	X	X	-
Undershoot R	X	X	-
SCR	X	x	-
2. CHARGING SUPPLY CONTROLLER			
a. Switch Imbalance	X	X	X
b. Current driver	X	X	X
c. Excess I	X	X	X
d. Excess V	X	X	X
e. SCR trig OK	X	X	X
e. Xductor OK CH_T_ST	X	X	X
e. Safety relay	X	X	X
f. Crowbar trig OK	X	X	-
g. Crowbar I	X	X	-
g. Water flow	X	X	-
g. Temp trips			
Tank 1	X	X	-
Tank 2	X	X	-
Holding R	X	X	-
SCR	X	X	-
h. ON/OFF	X	X	-

C. SAFETY RELAY READBACKS

Check that the closing of any of the 7 Safety Relays is detected in

the Safety Relay Controller.

D. DOOR INTERLOCK TEST
Bring up the interlock system, and then check that each door switch drops out the contactor and safety relays when opened.

E. CHARGING SUPPLY KEY SWITCH
Check that both key switch microswitches independently drop the Contactor and the Safety Relays.

F. CROWBAR TRIGGER TEST
Check that crowbar trigger circuit generates 200 - 500 Amp pulse into Ignitron ignitor terminal when the controller sends a crowbar command.

G. CROWBAR HEATER TEST
Check that ~ 7.6 volt AC (unloaded) is present at the ignitron contacts.
Measure the resistance across the terminals on the ignitron side, it should read ~ 12 Ohms.
Re-connect and measure the current with a clamp meter, it should read 0.5 amps.
make sure ignitron tube is warm to touch.

H. PFN WATER CIRCUIT CHECK
Check that water is hooked up to the following:
1. SCR switch
2. Undershoot resistor plate.
3. End of line diode

I. CHARGING SUPPLY WATER CIRCUIT CHECK
Check that water is hooked up to the following:
1. SCR switch in series with ignitron
2. Tank 1
3. Tank 2
4. Hold on resistor plate.
5. De Q resistor plate

J. INNER CABINET ISOLATION TEST
Measure resistance between PFN inner cabinet and ground with:
1. Safety relays energized. (makee sure cap bank is ungrounded)
2. Charging supply "capacitor bank return bus terminal" ungrounded.
3. PFN "inner cabinet ground terminal " ungrounded.
4. RG 220 cables not connected at transformer.

*** Resistance should be 50 Ohms ***

II NON-POWER TESTS AFTER SYSTEM IS SET UP TO RUN

A. WATER FLOW INTERLOCK TEST
1. Turn off valves to PFN and Charging Supply. Check that water flow interlocks drop out.
2. Turn off valves to transformer tank. Check that Stan Tawser's interlock drops out.

B. BIAS SUPPLY INTERLOCK TEST

Turn off bias supply and check that bias supply interlock drops out.

C. KLYSTRON INTERLOCK CHASSIS CHECK
Turn off Stan Tawser's interlock chassis and check that it turns off modulator.

D. LINAC SAFETY SYSTEM CHECK
Disconnect safety system inputs and check that modulator interlocks trip.

E. SAFETY RELAY INTERLOCK CHECK
Drop out Safety relays and check that modulator interlock trips.

F. CABINET GROUNDS
Check that there are cables from building ground to:
1. PFN Cabinet
2. Charging Supply cabinet.
3. Pulse transformer.
4. Modulator control rack.

G. PRIMARY SCR CONTROLLER CHECKS
Check that analog reference is present on contacts 31-30 on the SCR controller.
And bypass contact are wired to the primary SCR controller on contacts 1-12.

H. Visually check all power connections in the Charging Supply, PFN,
Pulse transformer. Use Fermi drawings 0231.00-ED-281003 and 2810099
as a guide.

III POWER ON TESTS

A. PHASE ROTATION (Optional)
Check phase rotation on input of Charging Supply 480VAC Switch.
1. Remove safety barrier from above 490VAC Switch.
2. Turn on Wall Breaker.
3. Measure phase rotation with 100:1 probe and memory scope.
4. Lock off Wall Breaker.
5. Measure input to 480VAC Switch to be Zero.
6. Return safety barrier above 480 VAC Switch.

B. TEST PRIMARY SCR CONTROLLER

****** This procedure shall only be done by system experts *****

1. Attach SCR controller output to "holding resistor"s only. Disconnect transformer primary.
2. Connect 480/120 power plug to relay control box.
3. Put Charging Supply controller in INHIBIT mode.
4. Set reference to zero.
5. Turn on Wall Breaker.
6. Turn on 480 VAC Switch on C.S. door.
7. Observe "AC ON" light and transformer warning light.
8. Energize Safety relays.
9. Turn on Charging Supply contactor.
10. Put Charging Supply controller in PERMIT mode.
Some signals may need to be jumpered.
11. Raise reference and observe voltage output on SCR controller panel.

12. Put charging Supply controller in INHIBIT" mode and note that voltage goes to zero.
13. Turn off Charging Supply contactor.
14. Put C.S. controller into PERMIT mode and observe that voltage is zero.
15. Put C.S. controller into INHIBIT mode.
16. Set reference to zero.
17. Turn and lockout 480 VAC Switch.
18. Lockout Wall Breaker.
19. Check for Zero volts at output of 480 VAC Switch.
20. Check for Zero volts at transformer primary terminals.
21. Reconnect output of SCR controller to transformer primary.

C. INITIAL SETTINGS

1. Set the following trip levels:

a. Excess charging current:	2.0 volts	(20 amps)
b. Excess cap. voltage:	5.0 volts	(10 kV)
c. Excess primary pulse current:	3.0 volts	(1800 amps)
d. Excess primary pulse voltage:	2.5 volts	(5 kV)
e. C.S. switch imbalance:	8.0 volts	
f. PFN switch imbalance:	8.0 volts	
g. EOL current:	3.0 volts	
h. Switch over-voltage:	5.0 volts	(10 kV)
i. C.S. Cap threshold:	1.5 volts	(3 kV)
j. Crowbar current:	1.0 volts	

2. Set C.S. switch balance to 4.0 volts.
3. Set PFN switch balance to 4.0 volts.

D. STEP THROUGH ACCESS-TYPE TURN ON PROCEDURE UP THROUGH CROWBAR TEST

E. CALL RADIATION SAFETY BEFORE PROCEEDING.

F. BRING MODULATOR ON AT 70KV 1HZ LEVEL (3.5 volts on C.S. switch voltage)

G. CHECK THE FOLLOWING TRIPS:
Decrease trip level until trip occurs.

	Pulse Inhibit	Bypass	Crowbar
1. PFN CONTROLLER			
a. Switch imbalance	X	X	X
b. Excess I	X	X	-
b. Excess V	X	X	-
2. CHARGING SUPPLY CONTROLLER			
a. Switch Imbalance	X	X	X
c. Excess I	X	X	X
d. Excess V	X	X	X

H. ON/OFF TRANSITION WHILE RUNNING. NOTE FILTER CAP VOLTAGE.

	Pulse Inhibit	Bypass	Crowbar
ON/OFF	X	X	-

I. Observe switch balance error signals (C.S switch and PFN switch) and adjust balance pots to minimize the errors. Photograph the error signals and record the pot settings.

J. Photograph and put in log book the following signals:
1. Primary current and voltage. Check turn-on di/dt.
2. PFN switch voltage.
3. EOL current. (should be 0 volts)

4. C.S. switch voltage and C.S current

K. CALL RADIATION SAFETY BEFORE PROCEEDING.

L. Increase the appropriate trip levels as necessary and bring modulator up to 100 kV.
   1. Observe switch balance error signals (C.S switch and PFN switch) and adjust balance pots to minimize the errors. Photograph the error signals and record the pot settings.
   2. Photograph and put in log book the following signals:
      a. Primary current and voltage. Check turn-on di/dt.
      b. PFN switch voltage.
      c. EOL current. (should be 0 volts)
      d. C.S. switch voltage and C.S current

M. Repeat step "K" and "L" in 30 kV steps until 180 kV is reached. At each step observe the PFN voltage at the end of the pulse to insure that the PFN SCRs are turning off properly.

N. Reduce voltage to 100 kV and increase repetition rate to 15 Hz.
   1. Observe switch balance error signals (C.S switch and PFN switch) and adjust balance pots to minimize the errors. Photograph the error signals and record the pot settings.
   2. Photograph and put in log book the following signals:
      a. Primary current and voltage. Check turn-on di/dt.
      b. PFN switch voltage.
      c. EOL current. (should be 0 volts)
      d. C.S. switch voltage and C.S current

EE SUPPORT TECHNICAL PROCEDURE

EE SUPORT DEPARTMET

ADDP-EE-0101

LINAC UPGRADE PULSE TRANSFORMER ELECTRICAL SAFEGUARD PROCEDURE

PREPARED BY _____ DATE _____

APPROVED BY _____ DATE _____

REVISION NO. _____ REVISION ISSUE DATE _____

CONTROLLED COPY NO. ____

REVIEW AND CONCURRENCE RECORD

REVIEWED BY: _____ DATE _____

REVIEWED BY: _____ DATE _____

REVIEWED BY: _____ DATE _____

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

The purpose of this procedure is to establish a safe method for qualified personnel to make the pulse transformer safe from an electrical hazard. Once this is acheived, the pulse transformer is made accessible for transport, service or repair.

2.0 INSTRUCTIONS

2.1 GENERAL SAFETY REQUIREMENTS

2.1.1 Two man rule must be observed at all times.

____2.1.2 Put on safety glasses.

2.2 REMOVING EXTERNAL POWER SOURCES

____2.2.1 Check that the breaker for that Modulator is locked out at panel DHP L-4-1.

____2.2.2 Check that the modulator is locked out at the 480 VAC ON/OFF switch located on the door of the charging supply.

____2.2.3 Inspect to see that the charging supply five ground straps in the high voltage compartment are ON.

Note: Four ground straps are connected between the high voltage bus (numbered 1 through 4) and ground. The fifth strap is connects the capacitor ground bus return terminal to ground.

____2.2.4 Inspect PFN cabinet to see that three ground straps are in place.

Note: Two straps ground coils L1 and L26.
One strap grounds the inner cabinet to ground.

____ 2.2.5 Ground the output side of the PFN Switch using the ground stick.

Note: You must open the PFN end cabinet doors and leave the ground stick hanging there until all work is completed at the pulse transformer.

____ 2.2.6 Turn off Filament Transformer breaker at control rack.

____ 2.2.7 Lock out the 208 VAC plug to the Filament Transformer Power Supply.

Note: use plug lockout box.

____ 2.2.8 Turn off Bias supply front panel switch.

____ 2.2.9 Lock out 208 VAC plug to the bias supply.

2.3 TRANSFORMER TANK ACCESS

____ 2.3.1 Open primary box by removing side plates.
Note: box is located on primary side of transformer.

____ 2.3.2 Apply ground stick to the transformer input connections.

____ 2.3.3 Apply ground stick to 0.1 uF capacitor terminals.

____ 2.3.4 Apply ground stick to 2000:1 voltage divider terminals.

____ 2.3.5 Apply ground stick to resistors.

____ 2.3.6 Open Filament transformer box.

____ 2.3.7 Measure with a Simpson voltmeter the primary side to ensure 208 VAC is not present.

____ 2.3.8 Apply ground stick to contacts separately.

____ 2.3.9 Open filament supply connection box.

____ 2.3.10 Apply the ground stick to each contact separately.

____ 2.3.11 Open the bias supply connections box.

____ 2.3.12 Apply the ground stick to the bias supply connections one at a time.

2.4 ACCESS OF TRANSFORMER PRIMARY BOX
Note: if work is to be done in the transformer primary box

____ 2.4.1 Open primary box by removing side plates.
Note: box is located on primary side of transformer.

____ 2.4.2 Apply ground stick to the transformer input connections.

____ 2.4.3 Apply ground stick to 0.1 uF capacitor terminals.

____ 2.4.4 Apply ground stick to 2000:1 voltage divider terminals.

____ 2.4.5 Apply ground stick to resistors.

2.5 ACCESS OF FILAMENT TRANSFORMER BOX
Note: if work is to be done in the filament transformer

____ 2.5.1 Open Filament transformer box.

____ 2.5.2 Measure with a Simpson voltmeter the primary side to ensure 208 VAC is not present.

____ 2.5.3 Apply ground stick to contacts.

2.6 ACCESS TO FILAMENT SUPPLY BOX

____ 2.6.1 Remove filament supply box on the lower front end of the transformer.

____ 2.6.2 Apply ground stick to the two contacts separately.

2.7 ACCESS BIAS SUPPLY CONNECTIONS

Note: If work is to be done in the box where connections to the primary side of the transformer are located.

____ 2.7.1 Open the bias supply connections box.

____ 2.7.2 Apply the ground stick to the bias supply connections one at a time.

3.0 EXTRA-DEPARTMENTAL DISTRIBUTION

3.1 To be distributed to LINAC department.

4.0 OPTIONAL CONTENT ELEMENTS

4.1 PREREQUISITES/INITIAL CONDITIONS

4.1.1 The pulse transformer electrical safeguarding procedure can be carried out by the following members of the E/E support group: Howie Pfeffer, Peter Prieto or Jack Lockwood. Members of the LINAC group can also perform this procedure, provided they have been properly trained to access the pulse transformer by an experienced member, such as Kermit Carlson. The person carrying out the procedure will use procedure number ADDP-EE-0101 named Pulse transformer electrical safeguarding procedure.

4.2 TOOLS AND MATERIALS

4.2.1 The person accessing the pulse transformer will require:

1. locks (up to 3 locks per person)
2. tags (for each of the locks used)
3. ground stick (this is permanently connected to the tank of the pulse transformer)
4. Pulse Transformer electrical schematics

4.3 SUPPORTING DOCUMENTS

4.3.1 The person accessing the pulse transformer must refer to drawing numbers:

1. 0231.00-EC-281568 Pulse Transformer Connections
2. 0231.00-MC-281569 Pulse Transformer Connections-Mech.

LINAC UPGRADE CHECK OUT LIST

Station Equipment Through the Smart Rack Monitors to Station Console

For Station _____

Digital Status From Chassis and NIM modules to the Smart Rack Monitor

The purpose of this check out list is to make sure that all analog and digital lines to the Smart Rack Monitor are correctly displayed by a station monitor. The NIM module or chassis name is in bold letters. Below the NIM module or chassis name is an address column and a name column. At any particular address the name should be displayed as shown in the name column.

If the address is a control line, as in the **Solenoid Coil P.S. Controller** address 160, a 0 indicates the control line is low and the unit is in the OFF state. A 1 indicates the control line is high and the unit is in the ON state. The unit must be in REMOTE and the interlocks for the NIM module or chassis must be made up for the REMOTE control to work.

A high level or 1 equals OK or ON unless noted otherwise. The unit being tested should be exercised to generate a fault (0) and OK (1). Both of these levels should be seen on the monitor. A RESET may have to be generated to clear a fault condition.

Veeder-Root Monitors

Address	Name	Initial when done
147	BC WIN SPARK DET	_____
146	WINDOW SPARK DET	_____
145	HV PULSE TOT MON	_____
144	GUN SPRK DET MON	_____

Transformer Temperature

Address	Name	Initial when done
143	XFMR TEMP LOW	_____
142	XFMR TEMP OK	_____
141	XFMR TEMP HIGH	_____

Water Flow Interlock Monitors

Address	Name	Initial when done
14F	CHG PS WATER FLOW	_____
14E	PFN WATER FLOW	_____
14D	WAVEG WATER FLOW	_____
14C	XFMR WATER FLOW	_____
14B	COLLR WATER FLOW	_____
14A	BODY WATER FLOW	_____
149	SOL B WATER FLOW	_____
148	SOL A WATER FLOW	_____

Interlock Reset

Address	Name	Initial when done	
15C	INTERLOCK RESET	_____	In the 15C line position the monitor cursor on the 0 and do an interrupt while observing the Interlock Chassis RESET LED. The RESET LED should light when the interupt causes the 0 to change to a 1. Do another interupt to change the 1 to a 0. Leave it at a 0.
15B	M4 INTLKMUX ADR3		Address 158 through 15B.
15A	M4 INTLKMUX ADR2		These 4 lines control the addressing to the Interlock Chassis.
159	M4 INTLKMUX ADR1		There is no requirement to check then at this stage.
158	M4 INTLKMUX ADR0		If the Interlock Chassis checks out OK then these 4 lines are OK.

Solenoid Coil P.S. Controller

Address	Name	Initial when done	
16E	REMOTE/LOCAL MON	_____	1=REMOTE, 0=LOCAL
16D	208V ON MONITOR	_____	
16C	COIL KLIXON OK	_____	
16B	COIL GND FAULT	_____	
16A	SOL B WATER FLOW	_____	
169	SOL A WATER FLOW	_____	
168	SOL PS ON/OFF MU	_____	
160	SOL REMOTE ON/OFF	_____	1=ON, 0=OFF

Klystron Vacuum Interlock

Address	Name	Initial when done	
170	VACUUM OK/BAD	_____	1=OK
17F	K ION PMP PS OFF	_____	1=OFF or HV cable dis.

Coil Ground Fault Detector

Address	Name	Initial when done
17D	COIL 6 GND FAULT	_____
17C	COIL 5 GND FAULT	_____
17B	COIL 4 GND FAULT	_____
17A	COIL 3 GND FAULT	_____
179	COIL 2 GND FAULT	_____
178	COIL 1 GND FAULT	_____

Filament Power Supply Monotors

Address	Name	Initial when done
20F	BLACK HEAT OK	_____
20E	BLACK HEAT HI	_____
20D	BLACK HT TIMR ON	_____
20C	FIL ON	_____
20B	LO VAC 1MIN FIL	_____
20A	VACUUM PERMIT OK	_____
209	208 V POWER ON	_____
208		
207	RED HEAT READY	_____
206	RED HEAT LOW	_____
205	RED HEAT OK	_____
204	RED HEAT HI	_____
203	RED HT TIMER ON	_____
202	RED HEAT ENABLED	_____
201	BLK HT TIME OUT	_____
200	BLACK HEAT LOW	_____

Coil Window Comparator

Address	Name	Initial when done
21D	COIL 6 INTERLOCK	_____
21C	COIL 5 INTERLOCK	_____
21B	COIL 4 INTERLOCK	_____
21A	COIL 3 INTERLOCK	_____
219	COIL 2 INTERLOCK	_____
218	COIL 1 INTERLOCK	_____

Interlock Chassis

Read the write up on the Interlock Chassis for an understanding of how it works. For each interlock input line there are three outputs to the Smart Rack Monitor. These are as followes:

1. NL NAME is a Non Latched monitor. For example NL SPARE 1
2. Latched monitors are not indicated. For example SPARE 1
3. Disabled monitor. For example DIS SPARE 1

The following is the test sequense for each of the interlock inputs. All channels must be enabled. Under the plastic door on the front panel check that all the switches are in the left position and there are no LED's on.

1. A high is applied to the input.
2. Generate a RESET bu pushing the front panel RESET switch.
3. Check that the latched indicator on the monitor is a 1.
4. Check that the non latched (NL) indicator on the monitor is a 1.
5. Remove the high input to the interlock channel.
6. Check that the latched indicator on the monitor is a 0.
7. Check that the non latched (NL) indicator on the monitor is a 0.
8. Apply a high input to the interlock channel.
9. Check that the latched indicator on the monitor is a still 0.
10. Check that the non latched (NL) indicator on the monitor is a 1.
11. Generate a RESET.
12. Check that both indicators read a 1 on the monitor.

Address	Name	Initial when done	Address	Name	Initial when done
197	NL WATER SYSTEM	_____	1AF	WATER SYSTEM	_____
196	NL SOL AB W FLOW	_____	1AE	SOL AB WATR FLOW	_____
195	NL XFMR WTR FLOW	_____	1AD	XFMR WATER FLOW	_____
194	NL WAVG WATR FLO	_____	1AC	WAVG WATER FLOW	_____
193	NL BODY WATR FLO	_____	1AB	BODY WATER FLOW	_____
192	NL COLL WATR FLW	_____	1AA	COLLR WATER FLOW	_____
191	NL COIL I COMPAR	_____	1A9	COIL I COMPATORS	_____
190	NL KLYSTRON VAC	_____	1A8	KLYSTRON VACUUM	_____
18F	NL K FIL R H RDY	_____	1A7	KLY FIL R H RDY	_____
18E	NL KLY GUN SPARK	_____	1A6	KLY GUN SPRK DET	_____
18D	NL WAVEGUID PRES	_____	1A5	WAVEGUIDE PRESS	_____
18C	NL RF LEAK DETCR	_____	1A4	RF LEAK DETECTOR	_____
18B	NL MODULATOR RDY	_____	1A3	MODULATOR READY	_____
18A	NL CAVITY VACUUM	_____	1A2	CAVITY VACUUM	_____
189	NL KLY WIND SPRK	_____	1A1	KLY WINDOW SPARK	_____
188	NL XFMR TANK TMP	_____	1A0	XFMR TANK TEMP	_____
187	NL SPARE 1	_____	19F	SPARE 1	_____
186	NL REFLECTD POWR	_____	19E	REFLECTED POWER	_____
185	NL MODR IN REGLN	_____	19D	MOD IN REGULAT'N	_____
184	NL CAVITY TMP OK	_____	19C	CAVITY TEMP OK	_____
183	NL CAV WATR FLOW	_____	19B	CAVITY WATER FLOW	_____
182	NL CAV SPARK DET	_____	19A	CAVITY SPARK DET	_____
181	NL SPARE 2	_____	199	SPARE 2	_____

1B3	LINAC INTERLK OK	_____	1=OK. Check by removing the Linac Interlock input to the Interlock Chassis.
1B2	CHARGE SWITCH ON	_____	1=ON, 0=OFF. Check by switching the Charge Switch ON and OFF.
1B1	KLYSTRON READY	_____	1= READY, 0= not READY - All interlocks must be made up.
1BO	MODULATOR ON	_____	1=ON, 0= OFF
198	RF ON IS ENABLED	_____	1=ENABLED

Interlock Chassis continued

Check to see if the disabled status is monitored correctly. Under the plastic front panel door move each switch to the right (interlock disabled position). The red LED will light and the monitor will change from 0 to 1 for that channel. Slide the switch back to the left (enabled position). The LED for that channel will go out and the monitor will indicate a 0 (interlock enabled)

Address	Name	Initial when done
1BF	DIS KLY VACUUM	_____
1BE	DIS WVG WTR FLOW	_____
1BD	DIS COIL I COMPS	_____
1BC	DIS XFMR WTR FLO	_____
1BB	DIS COIL WTR FLO	_____
1BA	DIS SOL AB WTR F	_____
1B9	DIS BODY WTR FLO	_____
1B8	DIS WATER SYSTEM	_____
1C7	DIS XFMR TNK TMP	_____
1C6	DIS RF LEAK DETR	_____
1C5	DIS KLY WIN SPRK	_____
1C4	DIS REFLCTD PWR	_____
1C3	DIS CAVITY VACUM	_____
1C2	DIS KLY GUN SPRK	_____
1C1	DIS MODULATOR RDY	_____
1C0	DIS KLY R H R	_____
1CE	DIS CAVTY TMP OK	_____
1CD	DIS SPARE 2	_____
1CC	DIS MOD IN REGUL	_____
1CB	DIS CAV SPRK DET	_____
1CA	DIS REFLCTD POWR	_____
1C9	DIS CAVTY WTR FL	_____
1C8	DISA SPARE 1	_____

Analog Voltage From Chassis and NIM modules to the Smart Rack Monitor

To check these analog monitors varie the source (Power Supply) or connect a 0 to 10 Volt power supply to the output cable.

On the index page open 4 COIL I & KLY FIL

Descriptor	Name			
K4INTL	INTERLOCK RESET	Do a Kbd. Int. while observing that the RESET LED lights for about 1 Sec.		
Descriptor	Name	Value	Initial when done	
K4SOL1	1LOC . . . OFF	AMP	_____	The Coil P.S.s can be turned ON and
		Check ON & OFF	_____	OFF by interupting on the ON and OFF.
Descriptor	Name	Value	Initial when done	
K4SOL2	COIL 2 CURRENT	AMP	_____	
K4SOL3	COIL 3CURRENT	AMP	_____	
K4SOL4	COIL 4 CURRENT	AMP	_____	
K4SOL6	COIL 5CURRENT	AMP	_____	
K4SOL6	COIL 6 CURRENT	AMP	_____	

Analog Voltage From Chassis and NIM modules to the Smart Rack Monitor continued

Filament Power Supply

To check these analog monitors, connect a 0 to 10 Volt power supply to the output cable.

Descriptor	Name	Value		Initial when done
K4FILV	FIL VOLTAGE		V	_____
K4FILI	FIL CURRENT		A	_____
K4FILP	FIL POWER		KW	_____

Turbine Flow Meter

To check these analog monitors, varie the source by valvling the flow off and on.

Descriptor	Name	Value		Initial when done
K4SWFA	SOL A WATER FL		GPM	_____
K4SWFB	SOLB WATER FL		GPM	_____
K4BFW	KLY BODY W FLO		GPM	_____
K4CFW	KLY COLL W FLO		GPM	_____
K4XWF	KLY XFMR W FLO		GPM	_____
K4WGWF	KLY WAVEGD FLO		GPM	_____
M4PWF	PFN WATER FLOW		GPM	_____
M4CSWF	CHG SUP WFLOW		GPM	_____

Klystron Vacuum

To check this analog monitor, connect a 0 to 10 Volt power supply to the output cable.

Descriptor	Name	Value		Initial when done
K4VAC	KLY VACUUM SIG		V	_____

INTERLOCK CHECK DATE _____ /_____/_____
STATION TUBE Sn. No._____

HARDWARE PROTECTION INTERLOCKS for klystron and RF. QAK FNAL 1/13/92
INITIAL WHEN THE TASK IS COMPLETED

1.0 Preparation

1.1_____ Interlocks for Personnel Protection on DC supply and PFN are checked out by E.E. Support.

1.2_____ Stanganes transformer after unpacking is first brought up to FNAL requirements by following the checklist of K. Carlson, then the Transformer can be used.

1.3._____ Solenoid, cabling and solenoid power supplies' Installation are first checked out by S. Fang, then interlocks can be checked as in this list.

2.0 KLYSTRON VACUUM. (DON'T APPLY FILAMENT POWER YET)

2.1_____ Red cable from klystron Ion pump to rack top. (Obie)

2.2_____ Small Varian Ion pump power supply mounted In rack, cabled all the way to Ion pump, turned on and reading klystron vacuum on It's front panel meter.

2.3_____ Klystron vacuum module mounted in rack, turned on, cabled to interlock box, to Varian Ion pump power supply and to filament supply chassis.

2.4_____ Test for correct operation: Unplug banana connector from back of Varian IP PS and use an adjustable power supply: Zero volts to negative or positive volts above that which corresponds to 100 micro amps should trip out interlock box and after I minute delay drop out filament chassis.

2.5_____ Reconnect banana connector and confirm interlocks are resettable.

2.6_____ Check that monitor and status cables go to rack monitor.

2.7_____ Check that klystron vacuum analog signal and digital status readouts show up correctly on the computer monitor.

2.8_____ Check with M. Popovic that mnemonic entries into database are correct as they read out.

3.0 KLYSTRON FILAMENT. (DON'T APPLY FILAMENT POWER YET)

3.1_____ Check that Filament chassis is properly mounted in rack

3.2_____ Set Variac dial to zero.

3.3_____ Check for correct Filament chassis external power wiring, from AC line and to Square D isolation xfmr. at Stanganes transformer.

3.4_____ Check that Stanganes transformer is grounded to the Ground Grid with large bare stranded copper cable and that case of Square D xfmr is grounded.

3.5_____ Obtain a copy of Klystron filament circuit DUMMY LOAD TEST DATA. This will show results for two cases: (1) Without dummy load and (2) with dummy load of 1 Ohm, 1000 Watts, the following Volts, Amps and Watts at the Filament chassis LED's for every 10 volts of Variac dial from Zero to Max. Variac setting.

3.0 KLYSTRON FILAMENT continued. (Do not turn filament on yet).

3.6_____ Obtain copy of tube data sheet for the exact klystron to be run, and note the manufacturer's recommended Filament voltage setting.(~25 V.)

3.7_____ Check that the Klystron is properly seated in socket and the oil level is satisfactory.

3.8_____ Tilt out filament chassis, open lid for access, energize carefully, raise Variac to give 250 Watts and wait for black heat to time out.

3.9_____ If klystron vacuum is so good that you do not get a "klystron vacuum OK" signal, temporary use a power supply at TTL hi to jumper the interlock.

3.10_____ Go to red heat. As the filament warms up, allowing some warm-up time, adjust the Variac to match tube filament voltage (mfr.'s rating) with a setting Interpolated from dummy load chart. (In order to achieve this step, black heat trip point can be moved as necessary and will be set right later.)

3.11_____ When red heat is timed out, check that the klystron filament ready light goes out and that interlock chain is now made up at that particular point.

3.12_____ Set red heat window levels 5% above and 5% below the center stable level.

3.13_____ Switch to black heat, observe that Interlock chain Is broken, wait for power to stabilize and then set black heat window levels 5% above and 5% below the center stable level.

3.14_____ Check that analog and digital cables from filament chassis go to rack monitor.

3.15_____ Check that Computer monitor scope reads out the filament voltage, current, power and with correct mnemonic labels.(mnemonics-M. Popovic).

3.16_____ Check that Veeder-Root panel Is mounted and powered.

3.17_____ Check that filament "on" signal is cabled to Veeder-Root rear panel. and that the filament timer channel is running.

3.18_____ Remove interlock Jumpers if it was installed in 3.9 above.

Notes:

1. Never turn filament all the way off except to change a tube.
2. Red heat must be on and timed out (45 minutes) to run modulator. If modulator is going to be down more than 48 hours, go to black heat until the next running period.
3. Red heat setting may be used to help warm up the oil, but should not be on more than 48 hours without modulator then being turned on to draw cathode current. RF Isn't required to be on in this step, but solenoid currents must be on at their correct values to run modulator. (see SOLENOID)
4. Because filament heat Is dissipated in the oil is not necessary for water flow to be on at this step (although usually it would be on).
5. A filament emission test (Miram plot) is to be done every 6 months: the delta I sub b must be less than 10% for a reduction of filament voltage to 95% E sub f. If the emission drops more, a higher Variac setting is made.)

4.0 WATER FLOW, OIL TEMPERATURE

4.1_____ Check that turbine flow modules are plugged into a powered NIM Bin at rack.
4.2_____ Check that properly-rated turbine flowmeters are plumbed into the water RETURN lines at the water headers.
4.3_____ Check that cables are connected from the turbine flowmeters all the way back to the turbine flow modules.(Cables outside rack-Obie)(inside rack-Bogie).
4.4_____ Cover Stanganes transformer with plastic raincoats and seal around klystron and solenoid as needed so that no water can get into transformer.
4.5_____ Water etches connect hoses, remove trapped air, flush as needed to prevent ruining the LCW resistivity, establish approximate flows and check for leaks. Repair if any leaks are found.
4.5.1_____Collector water hoses.
4.5.2_____Body water hoses.
4.5.3_____Solenoid water hoses, two sets.
4.5.4_____Transformer water hoses (doghouse water on supply hose).
4.5.5_____PFN water hoses.
4.5.6_____Charging supply water hoses.
4.6.0 With water flowing, slowly valve off water in each water circuit and see that each interlock drops out at the lower limit as It should. Lower limits are:
4.6.1_____Collector 30 GPM
4.6.2_____Body 8 GPM
4.6.3_____Solenoid A 5 GPM
4.6.4_____Solenoid B 5 GPM
4.6.5_____Transformer tank 3 GPM
4.6.6_____PFN 3 GPM
4.6.7_____Charging supply 10 GPM
4.7_____ Check that solenoid power is interlocked OFF unless water flow is OK.
4.8_____ Check that a computer readout is present for each flow and that each mnemonic is correct.(M. Popovic list).
4.9_____ Check that thermocouple assembly at Stanganes tank is coupled to TC amplifier in rack, is interlocked, and is read out correctly by computer.
4.10_____When it is clear that no leaks are present, plastic raincoat may be removed.

5.0 SOLENOID Interlocks

5.1_____ Check polarity of Klystron Solenoid Power Supply voltages at solenoid terminals for correct polarity.
5.2_____ Reinstall cover box over terminals.
5.3_____ Check that overtemp Klixons are mounted at top of solenoid, cabled to rack and connected up to interlock chassis. (cable by Obie, with cores).
5.4_____ Perform check to insure that Klixons shut off the solenoid power supplies If the solenoid case temperature exceeds 125 degrees F.
5.5_____ Water flow OK. Do 4.6.3 and 4.6.4 again and check that the Coil Power Supply Controller loses its permit.
5.6_____ Energize power supplies.
5.7_____ Record the Serial # of the tube installed. _____

5.8.0 For the first operational test, set the Coil currents to the value specified on the tube manufacturer's data sheet for the particular tube. Record these values in 5.8.1 to 5.8.6. When the tube is run in the test station a new set of Final Current Settings may be determined for the tube. Record these values, which can be found in the tube log book, in 5.8.7 to 5.8.12. These values are to be used when the tube is installed in a station.

Initial Current Settings	Final Current Settings from tube log book
5.8.1_____amps coil # I	5.8.7_____amps coil # I
5.8.2_____amps coil #2	5.8.8_____amps coil #2
5.8.3_____amps coil #3	5.8.9_____amps coil #3
5.8.4_____amps coil #4	5.8.10_____amps coil #4
5.8.5_____amps coil #5	5.8.11_____amps coil #5
5.8.6_____amps coil #6	5.8.12_____amps coil #6

(Final small current adjustments later by A. Moretti).

5.9_____ Set coil current comparators to permit + and - 5% adjustment at this stage.
5.10_____ Verify that interlock trips if any coil current goes outside its range, and that interlock can be reset when current is in range.
5.11_____ Check that coil currents read out on computer with correct mnemonic.

6.0 COLLECTOR & GUN.

NOTE: Install collector resistor before mounting x-ray lead shields around collector.

6.1_____ Record serial number of installed tube. Sn._____

Note: If the tube has a grounded collector, skip steps 6.2, 6.3, 6.4,6.7 and 6.8 in this section.
If the tube has an isolated collector, do all steps.

6.2_____ Install collector resistor, cabling to rack and on to klystron collector current module.
6.3_____ Apply test current of 10 amps from top of collector to transformer ground and verify that a 1 volt signal appears at input to collector module.
6.4_____ Reconnect cable to module.
6.5_____ Install lead x-ray shields around collector.
6.6_____ Check bolt torque on all shield bolts- 1 ft.-lb minimum.
6.7_____ Check that cable is installed to allow collector current readout on computer.
6.8_____ Apply test signal to verify that computer readout is scaled right and with proper mnemonic.
6.9_____ Install movable lead X-ray shield around Klystron output window and waveguide bend.
6.10_____ Check that moveable X-ray shield is locked in place.
6.11_____ Check that the Linac Safty System is connected to the Interlock Chassis and Modulator Safty Interlock and that breaking the Linac Safty System disables the Interlock Chassis and the Modulator Safty Interlock.

6.0 COLLECTOR & GUN continued

6.12_____ Verify that cables are installed from Stangenes transformer voltage divider and current transformer to rack and on to Gun voltage monitor and Gun current monitor NIM modules.

6.13_____ Verify cabling from Gun V and Gun I modules to Gun spark detector Veeder - Root driver and to Interlock chassis.

6.14_____ Undo V and I cables from Stinginess transformer and apply test signals to simulate gun spark. Interlock chain must drop out and V-R must count "gun sparks".

6.15_____ Still using test signals, this time simulating normal gun voltage, negative 9 volts at connector for V, normal gun current current, negative 5 volts at connector for I, verify that computer reads out -180 kV and -150 amps with proper mnemonic.

7.0 WAVEGUIDE & WINDOWS

7.1_____ Phototube mounted to view bend at klystron window and cabled to rack and on to phototube power supply and 2-channel PMT discriminator.

7.2_____ Phototube mounted to view bend at center bridge coupler window and cabled to rack and on to PMT power supply and 2-channel discriminator.

7.3_____ Pressure transducer mounted on waveguide, cabled to rack and on to waveguide pressure module.

7.4_____ Verify that waveguide pressure module reads out correctly at computer monitor, and is cabled to phototube power supply modules to permit PMT high voltage only when waveguide is pressurized.

7.5_____ Disconnect signal cable from PMT to discriminator. Apply test pulses to each discriminator channel separately to verify that Window spark counters (V-R) # I and #2 count correctly.

7.6_____ Reconnect PMT signal cables.

7.7_____ Check that V-R ten millisec pulses are cabled to smart rack monitor.

8.0 RF DRIVE

8.1_____ Mount Hewlett-Packard directional coupler on solenoid just above Type N connector to input cavity of klystron. Run cables back to rack. Input RF to klystron, directional coupler Forward signal, and directional coupler Reverse signal.

8.2_____ Mount klystron drive panel, and PST 500 Watt amplifier.

8.3_____ Insert into NIM bin the following: April RF detector, March RF detector, waveguide reflected energy module, nanosecond fault box (two slots).

8.4_____ Use Hewlett-Packard frequency source temporarily, mounted in rack .

8.5_____ Use temporary pulse generators to provide video gate.

8.6_____ Cable items above to provide RF drive to klystron.

8.7_____ Mount BNC and Type N patch panels as in A0 installation.

8.8_____ Using test pulses, check that a window #1 or #2 spark or a reflected energy pulse will truncate the RF drive and send a "Spark" count to the computer.

8.9_____ Using test pulses, determine that the S&H signals from March and April detectors are read out into the correct computer channels(C. Kerns and M. Popovic).

8.10_____ Install RF antenna, RF leak detector module, cables, and test with RF.

9.0 RECAP

9.1_____ Cavity water flow and cavity temperature OK interlock signals come from J. Crisp's cavity temperature system and must be cabled in and tested.

9.2_____ Cavity vacuum OK signals come from M. Shea by operating on analog signals from L. Bartelson and must be cabled in and tested.

9.3.0 The following interlock signals will have been tested by the above steps:

9.3.1 Coil current comparator
9.3.2_____ Klystron vacuum
9.3.3_____ Klystron filament ready
9.3.4_____ Klystron spark detector
9.3.5_____ Cavity spark detector
9.3.6_____ Waveguide pressure
9.3.7_____ RF leak detector
9.3.8_____ Window spark detector
9.3.9_____ Transformer tank temperature
9.3.10_____ Reflected power
9.3.11_____ cavity temperature OK
9.3.12_____ cavity water flow interlocks
9.3.13_____ cavity vacuum

10.0 Two more interlock signals, "Modulator Ready" and "Modulator in Regulation" come from the Pfeffer/Prieto rack and must be cabled to the interlock box.

10.1_____ "Modulator Ready" cabled to Pfeffer/Prieto rack.

10.11_____ "Modulator in Regulation" cabled to Pfeffer/Prieto rack.

LINAC UPGRADE

MODULATOR #_____

TO SECURE MODULATOR: PROCEDURE SHEET (21-Aug-91 version, revised 2-9-92)

NAMES _____/_____

DATE _____

REASON_____

_____

Written procedures are described here for the following operating conditions:

1. Turn on from an access state.

2. Turn off to an access state.

_____ Turn on, turn off and access of the modulator must be done under the TWO man rule. Operation of, or access to the Modulator can only be done under the direct supervision of Howie Pfeffer or Peter Prieto.

I. System Checkout: From an ACCESS state

A. Charging Supply Safety

___ 1. Put on film badge.

___ 2. Check that ALL PFN and CS DOORS and PANELS are CLOSED. If not, DO that.

___ 3. Turn ON waveguide gas pressure at Nitrogen Tank if necessary.

___ 4. Turn up the Filament from Black Heat. Time _____

___ 5. Check Charging Supply 480 VAC switch is locked OFF and key is REMOVED from cylinder.

___ 6. Switch conditions all on "LOCAL":

a. CS door;
b. PFN System Control board;
c. CS System Control board;
d. Phase Controller board;
e. de_Q_ing board.

___ 7. Make sure the "AC_INHIBIT" toggle switch is set to "INHIBIT" on CS System Control board.

___ 8. Reference phase voltage has been set to ZERO at Phase Controller.

___ 9. Looking through CS high voltage compartment window, observe that ALL FOUR safety relays are DOWN, GND straps are ON capacitor bank return bus terminal AND ON ALL FOUR capacitor bank high voltage buses.

B. PFN Safety

___ 1. Looking inside PFN cabinet through T-Box end windows, observe that ALL THREE safety relays are DOWN, GND straps are ON coils L1 and L26 and inner cabinet is GROUNDED.

___ 2. Put on safety glasses.

___ 3.

___ 4. Turn ON Firing Circuit A/C switch.

___ 5.

___ 6. While touching coil L1 with GND stick unground L1.

___ 7. While touching coil L26 with GND stick unground L26.

___ 8. Close inner cabinet.

___ 9. While touching inner cabinet with GND stick unground this cabinet.

___ 10. Close the doors.

C. Charging Supply preparation to turn on from ACCESS state

___ 1. Open high voltage compartment door.

___ 2. Inspect Supply for any obvious disconnections if necessary.

___ 3. While touching capacitor bank high voltage bus number 1 with GND stick, unground this bus.

___ 4. While touching capacitor bank high voltage bus number 2 with GND stick, unground this bus.

___ 5. While touching capacitor bank high voltage bus number 3 with GND stick, unground this bus.

___ 6. While touching capacitor bank high voltage bus number 4 with GND stick, unground this bus.

___ 7. While touching capacitor bank return bus terminal (CBRT) with GND stick, unground CBRT.

___ 8. Close the door.

D. Pulse Transformer Checkout

___ 1. Check Pulse Transformer sound box is GROUNDED.

___ 2. Ensure RF input to Klystron is properly connected or terminated.

___ 3. Make sure waveguide is terminated or else connected to the load.

D. Klystron Interlock Check

___ 1. Check oil temperature (90 F up to 140 F)._____

___ 2. Check flows at Flow Interlock modules.

___ 3. Ensure the vacuum interlock is activated. Vacuum current _____

___ 4. Solenoid supplies are powered ON (7 of them).

___ 5.

___ 6.

II. Actual Turn On

A. Charging Supply

___ 1. Open CS low voltage compartment doors.

___ 2. Check that firing circuit is ON.

___ 3. Check that the high voltage portion of the crowbar circuit are ON. Verify that the red neon light is ON.

___ 4. Close the doors.

___ 5. Turn on wall breaker cooresponding to the modulator # ___ at panel DHP L-4-1.

___ 6. Unlock 480 VAC switch by turning CS key all the way ON.

___ 7. Turn on CS 480 VAC switch, look for "AC_ON" light.

___ 8. Energize safety relays by pushing Relay Controller "RESET" button

at Control rack.

___ 9. Turn on Charging Supply contactor by depressing "ON" (red) button on the charging supply door.

___ 10. Before firing PFN, continue on to "TURN ON & ...SHEET" procedures

B. Crowbar Check

___ 1. Turn on "AC_INHIBIT" to "PERMIT" state at CS System Control board.

___ 2. Turn on Interlock "CHARGE SWITCH" (Stan's rack).

___ 3. Raise reference until switch voltage reads 1.0 Volt (2 KV) on DVM.

___ 4. Trigger crowbar by depressing momentary button labeled "crowbar trigger" located under the light link ketchall box.

___ 5. Look for "CROWBAR_I" trip at CS System Controller.

___ 6. Switch voltage should go to ZERO.

III. Turn Off

The following steps must be completed before access to cabinets is permited
****

A. Charging Supply Turn Off

___ 1. Set "AC_INHIBIT" switch to "INHIBIT" at CS System Control board.

___ 2. Set Phase reference voltage to ZERO at Phase Controller board.

___ 3. Trigger crowbar by removing twinax jumper on Control rack front panel.

___ 4. Look for "CROWBAR_I" trip at CS System Controller.

___ 5. Check that switch voltage of Charging Supply reads ZERO.

___ 6. Change switch at Stan's Interlock box to "OFF" position.

___ 7. Check that "ON/OFF" LED is turned "OFF" at CS System Control board.

___ 8. Toggle Filament Supply switch to Black Heat at RF Control rack.

___ 9. Turn contactor OFF by pushing green button on CS door.

___ 10. Rotate 480 VAC switch key clockwise to DROP safety relays.

___ 11. Turn off 480 VAC switch.

___ 12. Turn 480 VAC switch key full clockwise.

___ 13. Remove the key.

___ 14. See that warning light at Pulse Transformer is NOT flashing.

___ 15. Looking through CS high voltage compartment window, observe that ALL FOUR safety relays are DOWN.

___ 16. Lock out 480 VAC wall breaker DHP L-4-1.

B. PFN Grounding

___ 1. Looking inside PFN cabinet through T-Box end windows, observe that ALL THREE safety relays are DOWN.

___ 2. Put on safety glasses.

___ 3.

___ 4. Touch inner cabinet with resistor stick.

___ 5. Touch inner cabinet with GND stick.

___ 6. While touching inner cabinet with GND stick clamp the cabinet to GND.

___ 7.

___ 8. Touch C1,L1 and C26,L26 using resistor stick.

___ 9. Touch C1,L1 and C26,L26 using GND stick.

___ 10. While touching L1 with GND stick clamp L1 to GND.

___ 11. While touching L26 with GND stick clamp L26 to GND.

___ 12. Turn off Firing Circuit A/C switch.

___ 13.

___ 14. Close the doors.

C. Charging Supply Grounding

___ 1. Open CS low voltage compartment doors.

___ 2. Measure 480 VAC at ALL THREE phases AND between ALL THREE wires and GND at output 480 VAC switch, ALL should read ZERO.

___ 3. Turn OFF crowbar toggle and DISCHARGE crowbar 1.5KV source by pushing "DISCHARGE" botton until light stays OFF.

___ 4. Turn off Firing Circuit for SCR switch.

___ 5. Close the doors.

___ 6. Open CS high voltage compartment door.

___ 7. Check that shorting relay KC-3 is grounding capacitor bank return bus.

___ 8. Touch capacitor bank return bus terminal (CBRT) with resistor stick.

___ 9. Touch CBRT with GND stick.

___ 10. While touching CBRT with GND stick clamp CBRT to GND.

___ 11. Touch EACH capacitor bank terminals with resistor stick.

___ 12. Touch EACH capacitor bank terminals with GND stick.

___ 13. While touching capacitor bank high voltage bus number 1 with GND stick clamp GND on this bus.

___ 14. While touching capacitor bank high voltage bus number 2 with GND stick clamp GND on this bus.

___ 15. While touching capacitor bank high voltage bus number 3 with GND stick clamp GND on this bus.

___ 16. While touching capacitor bank high voltage bus number 4 with GND stick clamp GND on this bus.

___ 17. Close the door.

****
* Keep the key with You while accessing Modulator equipment!*
****

IV. Preparing to work BEHIND any PFN inner cabinet PANEL

****
The TURN_OFF procedure must be completed before access to cabinets is permitted!
****

___ 1. Remove panel.

___ 2. Touch capacitors and coils at BOTH ends of panel opening with

resistor stick.

___ 3. Touch capacitors and coils at BOTH ends of panel opening with GND stick.

___ 4. While touching coils with GND stick clamp coils at BOTH ends of panel opening to GND.

___ 5. Touch EACH capacitor in panel opening with resistor stick.

___ 6. Touch EACH capacitor in panel opening with GND stick.

RF SYSTEM COMMISSIONING PROCEEDURE

H. Pfeffer
A. Moretti
6/13/92

This is a proceedure for turning on an RF system for the first time. The steps are chosen to bring up the system in a manner that is safe for both personnel and equipment.

COMMISSIONERS _____

DATE_____

A. PRE-OPERATIONAL CHECKOUT COMPLETION

___1. Modulator commissioning proceedure has been completed.

___2. LINAC UPGRADE CHECKOUT LIST has been completed.

---3. HARDWARE PROTECTION INTERLOCKS FOR KLYSTRON AND RF has been completed.

B. SYSTEMS STARTUP

___1. Klystron RF drive signal is OFF.

___2. Bring modulator to readiness following the ACCESS PROCEDURE SHEET.

C. INITIATE DC PULSING WITHOUT RF AT LOW VOLTAGE

___1. Call radiation safety officer to monitor radiation levels.

___2. Radiation safety officer is present and ready to survey.

___3. Set modulator rep. rate to 1 PPS.

___4. Klyston vaccuum = _____

___5. Turn on CHARGE SWITCH on Klystron interlock chassis.

___6. Run modulator at 70 kV cathode voltage.

___7. Check for NO spurious RF on direcional couplers. Call experts otherwise.

___8. Check RF Leak detector signal for NO excessive RF leakage.

___9. Radiation levels have been surveyed and are safe at this level.

___10. Fasten radiation survey results in the operations Log book.

___11. Measure perveance

___12. Record output cavity thermocouples. _____ _____

___13. Call expert to check above readings.

___14 Thermocouples are OK.

___15. Klystron Vaccuum better than 20 uA.

___16. Sparking is reasonable. Call experts otherwise.

___17. Modulator experts satisfied.

___18. Klystron experts satisfied.

D. INCREASE DC PULSING LEVELS WITHOUT RF

I. 100 KV LEVEL

___1. Call radiation safety officer.

___2. Radiation safety officer is present and ready to survey.

___3. Klystron vaccuum = ____

___4. Run modulator at 100 kV cathode voltage.

___5. Check for NO spurious RF on directional couplers. Call experts otherwise.

___6. Check RF leak detector signal for NO excessive RF leakage.

___7. Radiation levels have been surveyed and are safe at this level.

___8. Measure perveance.

___9. Record output cavity thermocouples. _____ _____

___10. Call expert to check above readings.

___11. Thermocouples OK.

___12. Klystron vaccuum is better than 20 uA.

___13 Sparking is reasonable. Call experts otherwise.

___14. Modulator expert satisfied.

___15. Klystron expert satisfied.

II. 130 kV LEVEL

___1. Call radiation safety officer.

___2. Radiation safety officer is present and ready to survey.

___3. Klystron vacuum = _____

___4. Run modulator at 130 kV level.

___5. Check for NO spurious RF on directional couplers. Call experts otherwise.

___6. Check RF leak detector for NO excessive RF leakage.

___7. Radiation levels have been surveyed and are safe at this level.

___8. Measure perveance.

___9. Record output cavity thermocouples. _____ _____

___10. Call expert to check above readings.

___11. Thermocouples OK.

___12. Klystron vacuum is better than 20 uA.

___13. Sparking is reasonable. Call expert otherwise.

___14. Modulator expert satisfied,

___15. Klystron expert satisfied.

III. 160 kV LEVEL

___1. Call radiation safety officer.

___2. Radiation officer is present and ready to survey.

___3. Klystron vacuum = _____

___4. Run modulator at 160 kV cathode voltage.

___5. Check for NO spurious RF on directional couplers. Call experts otherwise.

___6. Check RF leak detector signal for NO excessive RF leakage.

___7. Radiation levels have been surveyed and are safe at this level.

___8. Measure perveance.

___9. Record output cavity thermocouples. _____ _____

___10. Call expert to check above readings.

___11. Thermocouples OK.

___12. Klystron vacuum is better than 20 uA.

___13. Sparking is reasonable. Call expert otherwise.

___14. Modulator expert satisfied.

___15. Klystron expert satisfied.

IV. 180 kV LEVEL

___1. Call radiation safety officer.

___2. Radiation safety officer is present and ready to survey.

___3. Klystron vacuum = ___

___4. Run modulator at 180 kV cathode voltage.

___5. Check for NO spurious RF on directional couplers. Call expert otherwise.

___6. Check RF leak detector for NO excessive RF leakage.

___7. Radiation levels have been surveyed and are safe at this level.

___8. Measure perveance.

___9. Record output cavity thermocouple readings. _____ _____

___10. Call expert to check above readings.

___11. Thermocouples OK.

___12. Klystron vacuum is better than 20 uA.

___13. Sparking is reasonable. Call experts otherwise.

___14. Modulator expert satisfied.

___15. Klystron expert satisfied.

E. INITIATE PULSING WITH RF

___1. Check that pulse rep. rate is 1 PPS.

___2. Check that modulator is running at 180 kV.

___3. Call radiation safety officer to monitor radiation levels.

___4. Radiation officer is present and ready to survey.

___5. Check that forward and reverse directional coupler signals are on scope, and that scope gains are set to 10 mV/cm.

___6. Scope is triggered on PFN firing pulse.

___7. An operator is stationed to monitor cavity Ion guage readouts.

___8. Set RF pulse width to 10 u.s.

___9. Set RF attenuation level on RF signal source to maximum attenuation.

---10. Activate RF output of signal source.

___11. Increase signal level until RF signal is detected on directional coupler.

___12. Record output cavity thermocouple readings. _____ _____

___13. Call expert to check above readings.

___14. Thermocouples OK.

___15. Calculate RF power level from directional coupler signals.

___16. Check that cavity vaccuum is low.

___17. Check cavity spark detector for reasonable spark rate.

___18. Tune RF frequency to minimum reflected power.

___19. Check the cavity sum pickup for RF signals.

___20. Tune RF frequency for maximum cavity sum pickup signal.

___21. Note difference between this and minimum reflected power frequency.

___22. Consult with cavity experts.

___23. Radiation levels have been surveyed and are safe at this level.

___24. Check that cavity vaccuum and spark rate are low.

___25. Fasten this proceedure in A-0 RF system Log book when complete.

F. RAISE RF LEVEL IN STEPS

Follow instructions on "RF Increment Commissioning Proceedure" sheets.

RF INCREMENT COMMISSIONING PROCEEDURE

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5/4/92

This is a proceedure for raising the RF level on the cavities for the first time. The steps are chosen to raise the RF power level in a manner that is safe for personnel and equipment.

COMMISSIONERS _____
DATE _____

A. OPERATION LEVEL PRIOR TO DOING THIS PROCEEDURE

___1. RF commissioning proceedure has been completed through step E.

___2. Modulator is running at 180 kV, 1 PPS.

___2. RF is turned on at or below previously commissioned level.

___3. RF pulse width is 10 u.s.

B. PROCEEDURE TO INCREMENT RF POWER LEVEL

___1. Call radiation safety officer to monitor radiation levels.

___2. Radiation safety officer is present and ready to survey.

___3. Check that forward and reverse directional couplers are on scope.

___4. RF signals should be present.

___5. An operator is staioned to monitor cavity Ion guage readouts.

___6. Increase RF signal level until whichever of the following occurs first:

- ___6.1 Radiation officer says to stop incrementing.
- ___6.2 Cavity spark rate exceeds 50%.
- ___6.3 Cavity vacuum exceeds 2.0 E-6 Torr.

___7. Record output cavity thermocuple readings. _____ _____

___8. Call expert to check above readings.

___9. Thermocouples OK.

___10. Calculate RF power level. _____

___11. Calculate gap voltage level. _____

___12. Tune RF frequency to minimize reflected power. F= _____

___13. Tune RF frequency for maximum power on the cavity sum pickup.
F= _____

___14. Note difference between these two frequencies. _____

___15. Consult cavity expert.

___16. Radiation levels have been surveyed and are safe.

___17. Radiation survey results are posted in operations Log Book.

___18. Continue at this level until vacuum is better than 2.0 E-7 Torr, and cavity spark rate is less than 1%.

___19. Fasten this completed sheet in A-0 operations Log book.

___20. Get another RF Increment Proceedure sheet and proceed until a maximum of 8 MW is reached.